Detection of an exoplanet by star movement - Presentation

Exoplanets are not bright enough to be seen, but they can be massive enough to cause the stars they orbit to *move*. The first goal of this activity is to grasp the concept of centre of gravity of two objects. Then, by observing the movement of stars, guess if their movement can reveal the presence of planets?

Level: primary school

Objectives

- Approach the notion of centre of gravity
- Detect the presence of planets in star fields.

Materials required:

- Wooden or bamboo stick (50 cm)
- String
- Packets weighing 1kg, 500g, 250g, 100g (pasta, sugar, etc.) two of each

Duration: about 1 hour

Activity plan: see attached document.

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Detection of an exoplanet by star movement – Lesson plan

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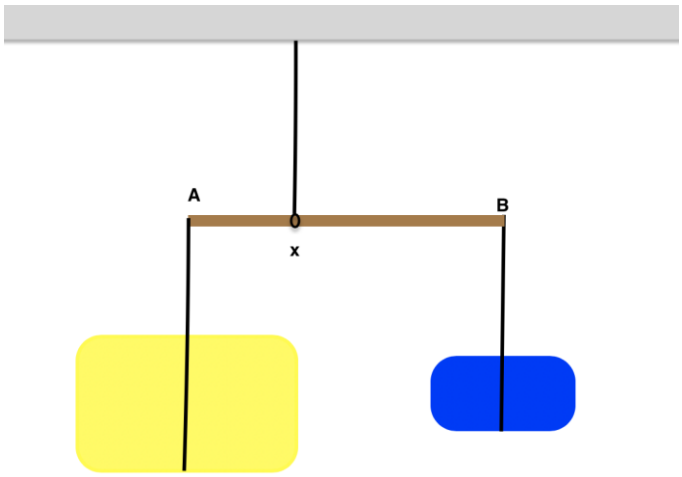
- Approach the notion of centre of gravity
- Detect the presence of planets in star fields.

Part 1: seeking balance

Prepare le following apparatus:



1. Tie a noose on a 30cm string and tighten it at the middle of the stick (x).
2. Attach the string and the suspended stick to a fixed support.
3. Tie a 20cm string to each end of the stick (A and B), and attach two packets with them
4. Have the pupils look for the position where balance is found (i.e. “when the stick is horizontal again”)
5. Measure the xA and xB lengths in the following cases:

Weight A	Weight B	xA	xB
100 g	100 g		
250 g	250 g		
250 g	100 g		
500 g	500 g		
500 g	250 g		
500 g	100 g		
1 kg	1 kg		
1 kg	500 g		
1 kg	250 g		
1 kg	100 g		

6. What do we observe? Explain explicitly “the point of balance between tow objects is called the centre of gravity”.
7. In the latter case (1 kg vs 100 g) have the balanced pair rotate around the noose. How do both packets move?

Part 2: application – finding invisible planets

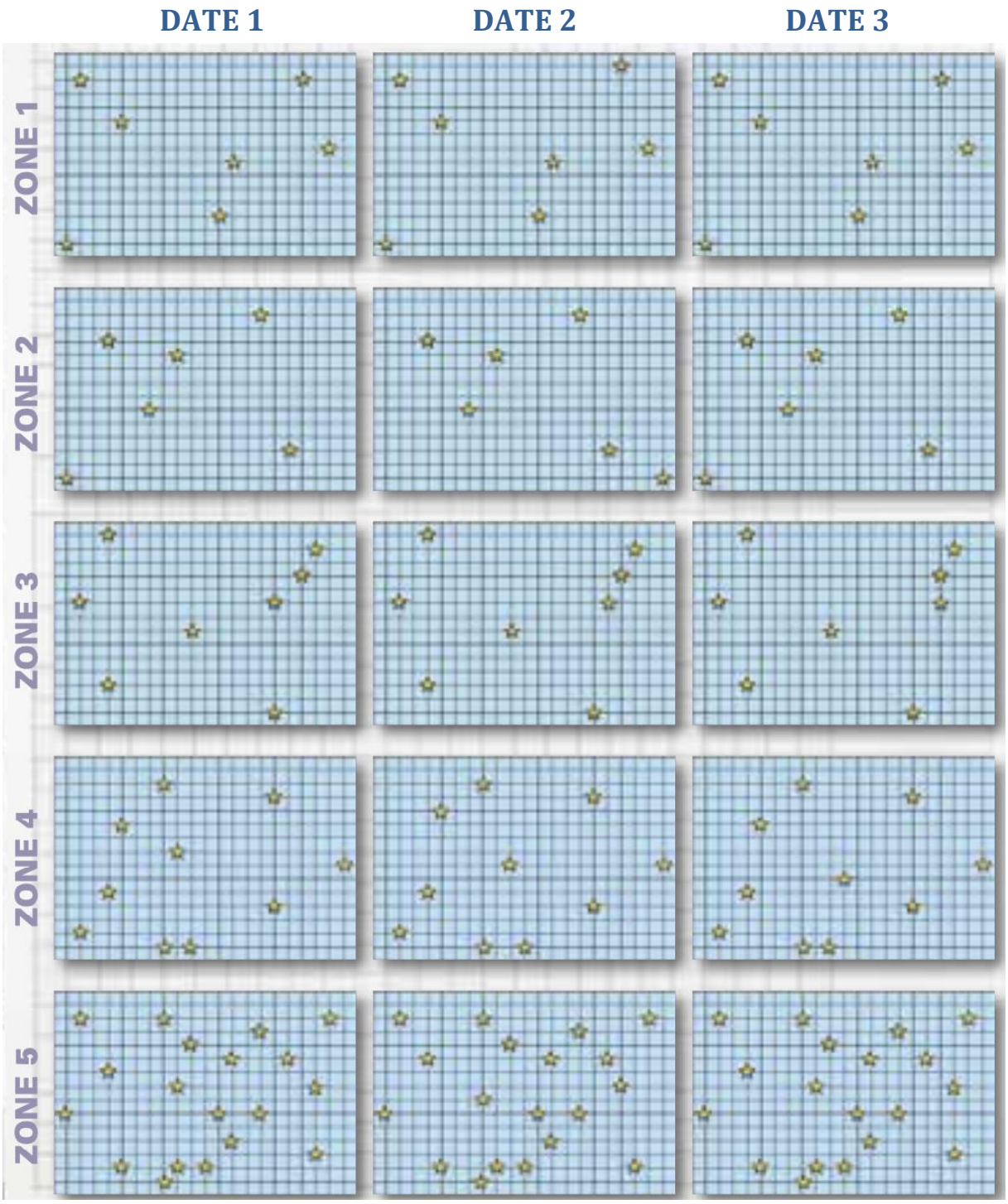
Explain that the latter case could be a star and its exoplanet (there do exist exoplanets systems with a star-to-planet mass ratio of 10, but in the case of the Solar System, Jupiter, the biggest planet, is only 1,000 times lighter than the Sun). Both the star and the planet revolve round the centre of gravity of the two bodies. From far away, like from the Earth, we could see the star swing or zigzag even though we do not detect the exoplanet.

On the other hand, a star moving in a straight line, or not moving at all, will probably not have exoplanets.

Distribute the Appendix to the pupils, with the following instructions:

1. These are five regions of the sky, observed at three different dates. For each of these stars, compare their position as time goes by.
2. Did some stars move?
3. If they did, was it a straight or a zigzag movement?
4. Can you tell which stars have planets?

Detection of an exoplanet by star movement – Appendix – star fields



Detection of an exoplanet by star movement – Solution

Part 1 – seeking balance

The first observations will be:

- When both packets are identical, the noose is right in the middle.
- When the packets are different, the noose must be closer to the heaviest one.
- When a packet is X times heavier than the other, then the noose is also X times closer to the heaviest one.
- When the system revolves, the lightest packet moves much more than the heaviest one.

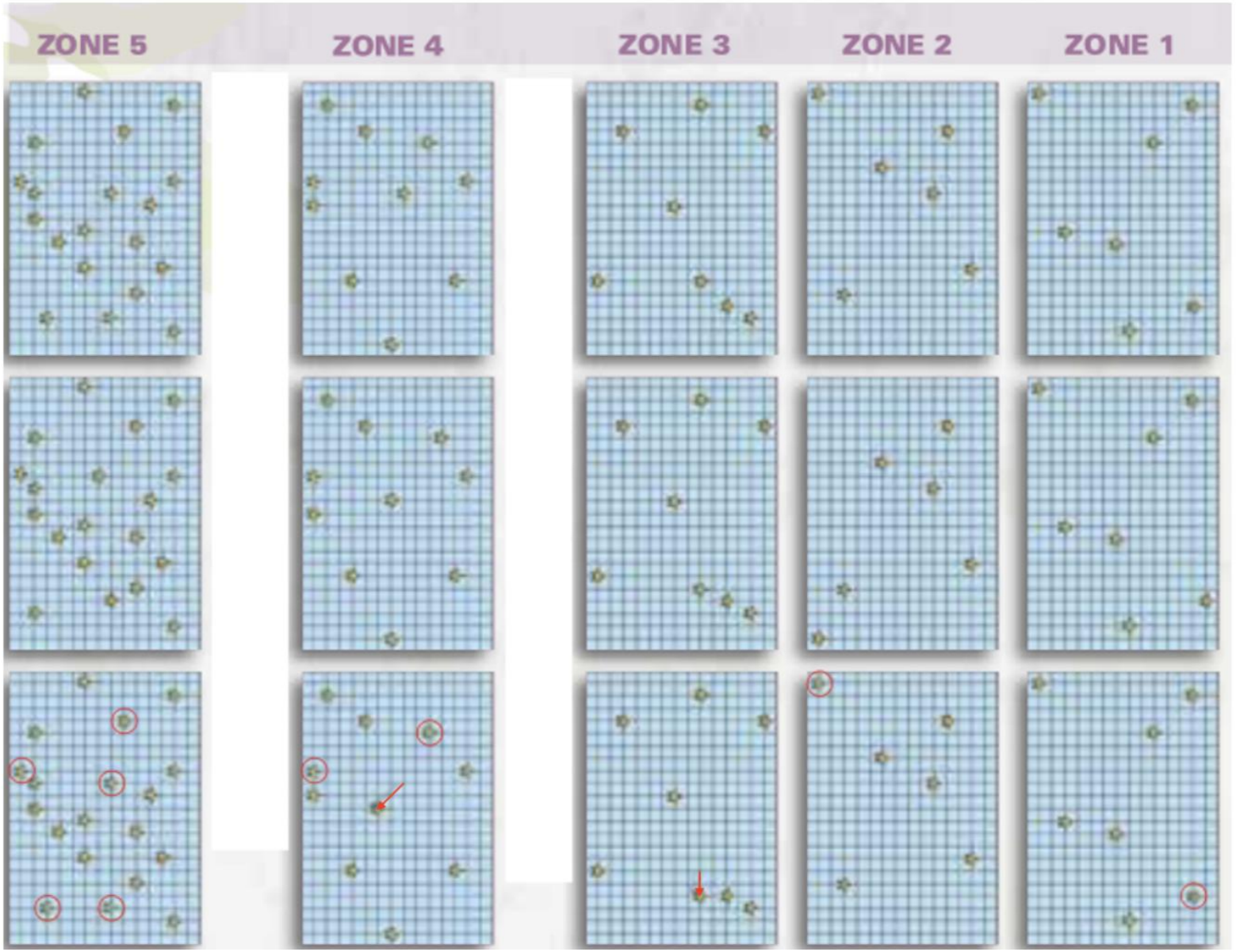
Weight A	Weight B	xA	xB
100 g	100 g	25 cm	25 cm
250 g	250 g	25 cm	25 cm
250 g	100 g	14 cm	36 cm
500 g	500 g	25 cm	25 cm
500 g	250 g	17 cm	33 cm
500 g	100 g	8 cm	42 cm
1 kg	1 kg	25 cm	25 cm
1 kg	500 g	17 cm	33 cm
1 kg	250 g	10 cm	40 cm
1 kg	100 g	5 cm	45 cm

Part 2 – finding invisible planets

In each field, the stars circled in red are swinging: this indicates that they have planets around them.

The fields #3 and #4, some stars move in a straight line (indicated by a red arrow). They probably don't have planets.

All the other stars probably don't have planets either.


ZONE 5
ZONE 4
ZONE 3
ZONE 2
ZONE 1